Game Changing Transformable Entry System Technology Applicability to Robotic Venus Science Missions (TEST)

Completed Technology Project (2011 - 2012)

Project Introduction

The innovative adpative deployable entry and placement technology (ADEPT), also known as transformable entry system technology (TEST) concept, akin to an umbrella, is a deployable structure with a flexible thermal protection system (TPS), which addressed the grand challenge of landing 40 mT payloads at Mars. TEST was shown to be a viable, robust, easier to integrate with human Mars entry, descent and landing (EDL) architectures, mass competitive, and potentially less expensive to develop compared to other EDL options.

Our goal is to apply the ADEPT concept to robotic Venus missions, establish the entry system characteristics, and broaden the viability of the concept. The proposal will evaluate and establish the applicability of ADEPT by performing trade studies and risk reduction tasks. Design assessment and focused testing will further address key risk areas and demonstrate concept viability. The tasks will address key challenges: 1. Parametric evaluation of the Venus Entry for a range of ballistic coefficient configurations 2. Establish entry conditions and requirements for ballistic and lifting trajectories 3. Develop aerothermal data to establish requirements for loads 4. Assess aero stability and establish payload requirements for Science packaging studies. 5. Establish mass estimate for a range of configurations (2m – 16m) configurations. 6. Perform exploratory arc jet testing of the Carbon Cloth at JSC arc jet with CO2,depending on the availability and funding for making models. Partnership: Ames Research Center (ARC) will partner with Goddard Space Flight Center (GSFC), which will perform Venus science focused trade studies and also act as Science consultant. Johnson Spaceflight Center (JSC) will perform exploratory arc-jet testing in CO2 at relevant conditions for Venus missions. Impact: Limited studies performed to-date show low ballistic coefficient entry environments are orders of magnitude more benign than those associated with rigid aeroshells. Entry load can be effectively lowered from 300g to 25g. Benign entry environment will result in lower development and qualification costs for missions. TEST architecture has the potential for inclusion of sensitive science instruments not possible with rigid aeroshells and also may make packaging easier. If TEST is shown viable for Venus missions, it has the potential to be game changing and cross-cutting for both human and robotic missions to Mars (previously studied), Venus, and by extension to Saturn. As result of this effort, an aerothermal data base for Venus entry was generated and used in establishing entry conditions for assessing the applicability of deployable entry system. The study demonstrated a 6m ADEPT is capable of delivering the same payload as the VITaL study, a mission design study conducted in support of NASA's Planetary Science Decadal Study by a National Research Council (NRC) team. The entry peak heat-flux experienced by ADEPT will be an order of magnitude smaller and the entry declaration will be 30'gs or below.

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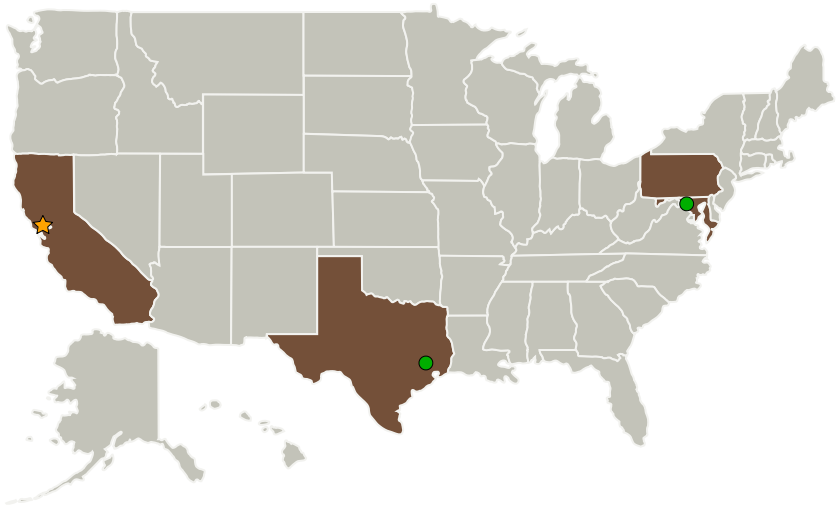
Anticipated Benefits

Establishing the nature of the TEST concept for both near term Venus missions and longer term human missions to Mars allows the Office of the Chief Technologist (OCT) Game Changing and Cross-Cutting offices to invest in the development of TEST and allow NASA ARC to be an innovative leader in the Entry System Technologies for decades to come, with the potential low investment, high pay-off, that leverages our partners' strengths to address high risks.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
ERC Inc.	Supporting Organization	Industry	
●Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
●Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Harry Partridge

Project Manager:

Ethiraj Venkatapathy

Principal Investigator:

Ethiraj Venkatapathy

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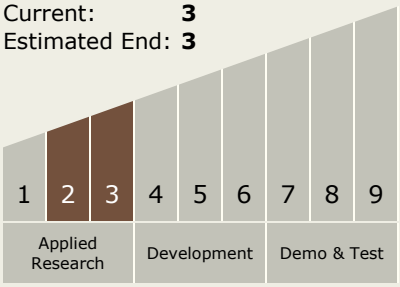
Co-Funding Partners	Type	Location
Bally Ribbon Mills(BRM)	Industry	Bally, Pennsylvania

Primary U.S. Work Locations	
California	Maryland
Pennsylvania	Texas

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.1 Aeroassist and Atmospheric Entry
    - TX09.1.2 Hypersonic Decelerators